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TRANSIMS Feedback Modeling

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LOS ALAMOS
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TRANSIMS FEEDBACK MODELING

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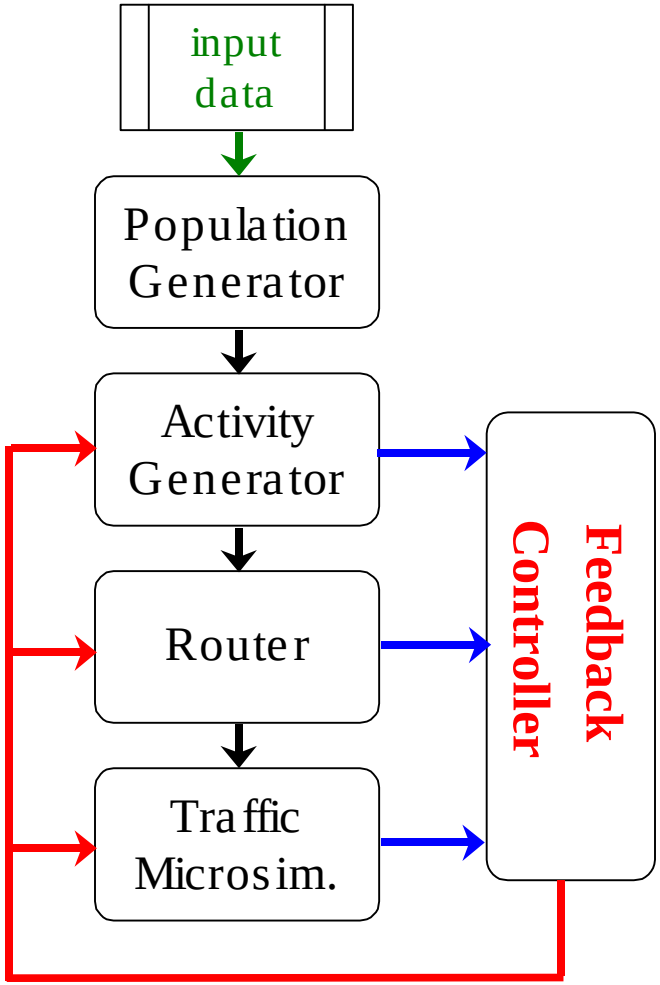
OUTLINE

- *Introduction*
- *Preliminaries & Definitions*
- *Tools*
- *Examples*
- *Summary*

INTRODUCTION

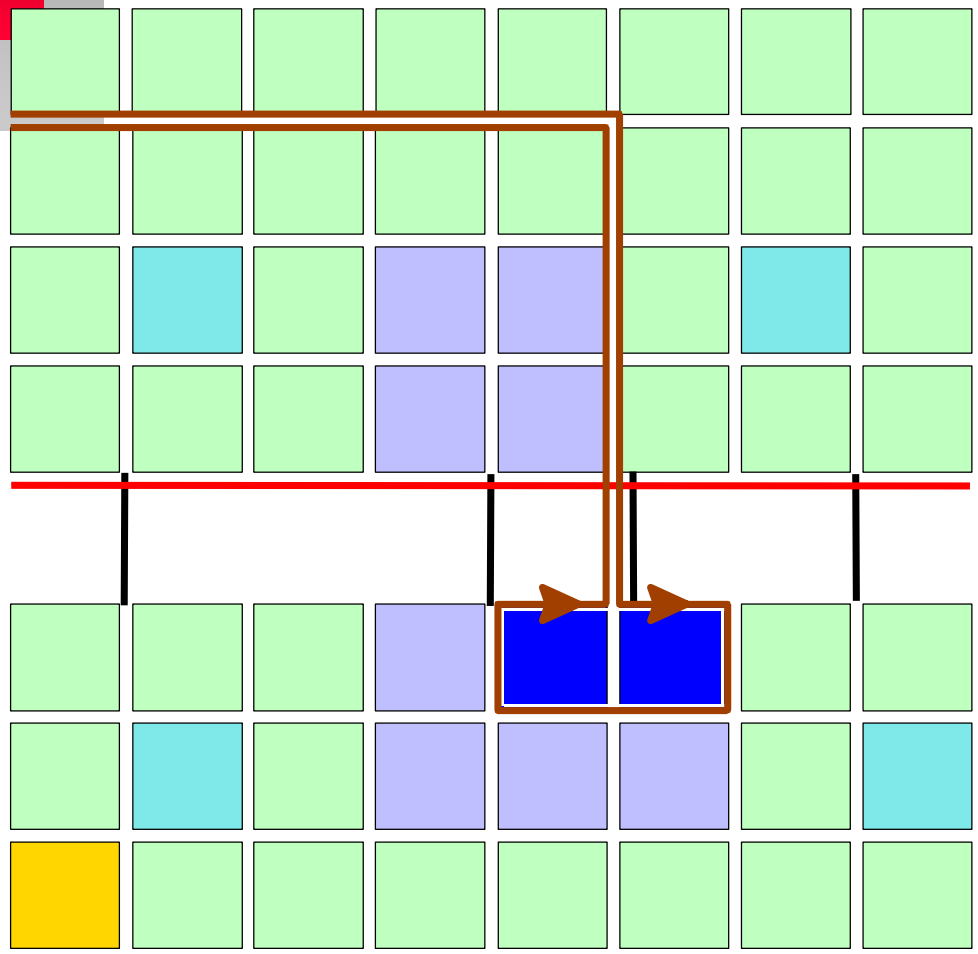


- *What is feedback?*
- *Why do we need it?*
- *How do we use it?*

PRELIMINARIES & DEFINITIONS

- *Bignet notional network*
- *Targets*
- *Cost Functions*
- *Stratification*
- *Stopping Criteria*

PRELIMINARIES: The Bignet Network



Heavy Commercial

Light Commercial

Heavy Industrial

Light Residential

Mixed: Res./Comm.

Freeway

Light Rail

Bridge

PRELIMINARIES: Targets

The goal of feedback could be to …

- *Achieve a Nash equilibrium in route choice minimizing travel times*
- *Determine a cost function to yield a desired mode split*
- *Correct location choice to account for travel times between activities*
- *Forecast a mode split given a current scenario and a "future change"*

PRELIMINARIES: Cost Functions

Represent the Utility of a choice (mode, location, route, etc.)

May (or may not) be different cost functions for different purposes

- *Example:*

cost ~ travel time + dollar cost

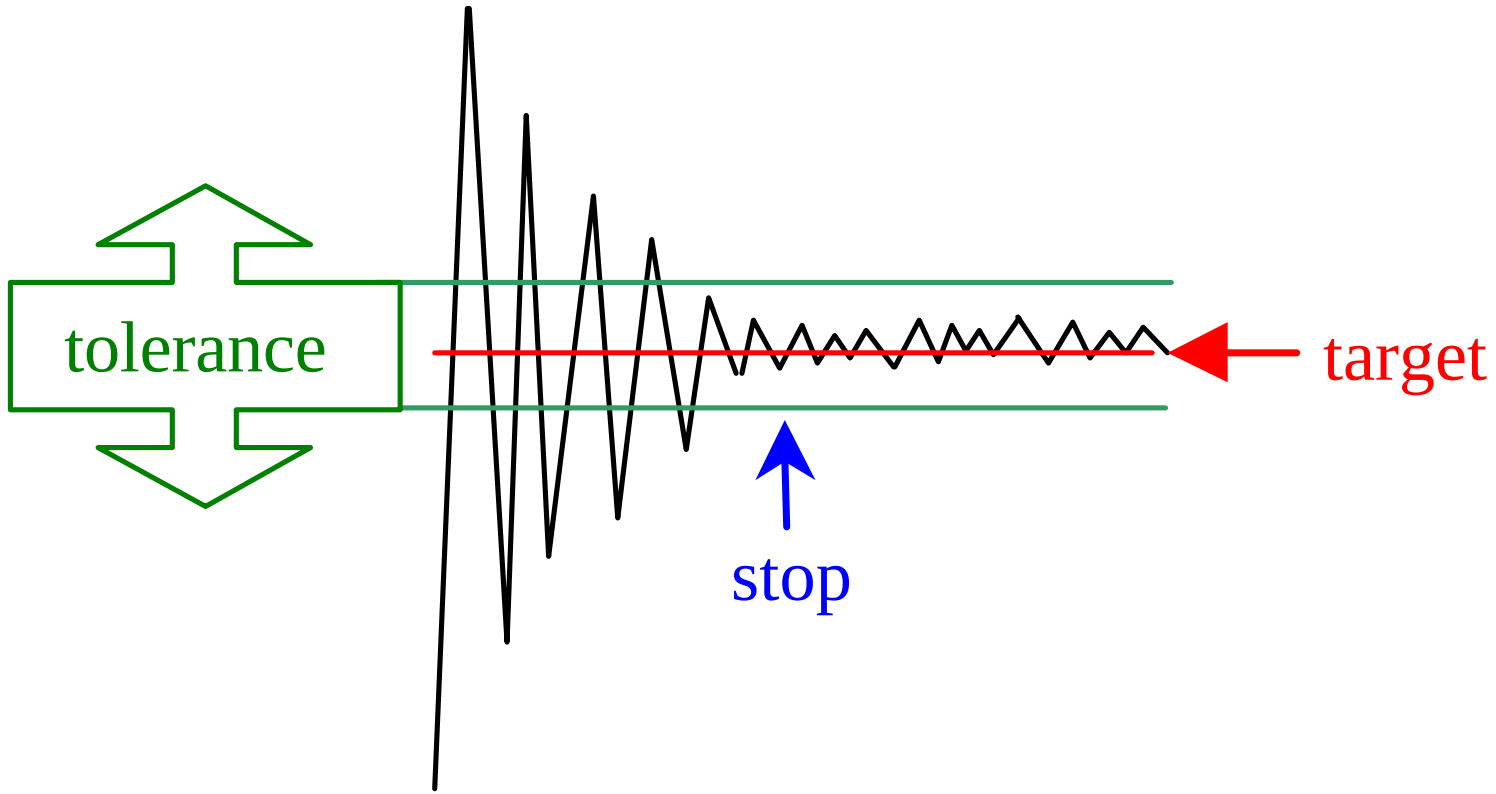
PRELIMINARIES: Stratification

- *Groups travelers with similar preferences, demographics and/or experiences*

	cross river	no river
poor	A,D,G	B
wealthy	E,F	C

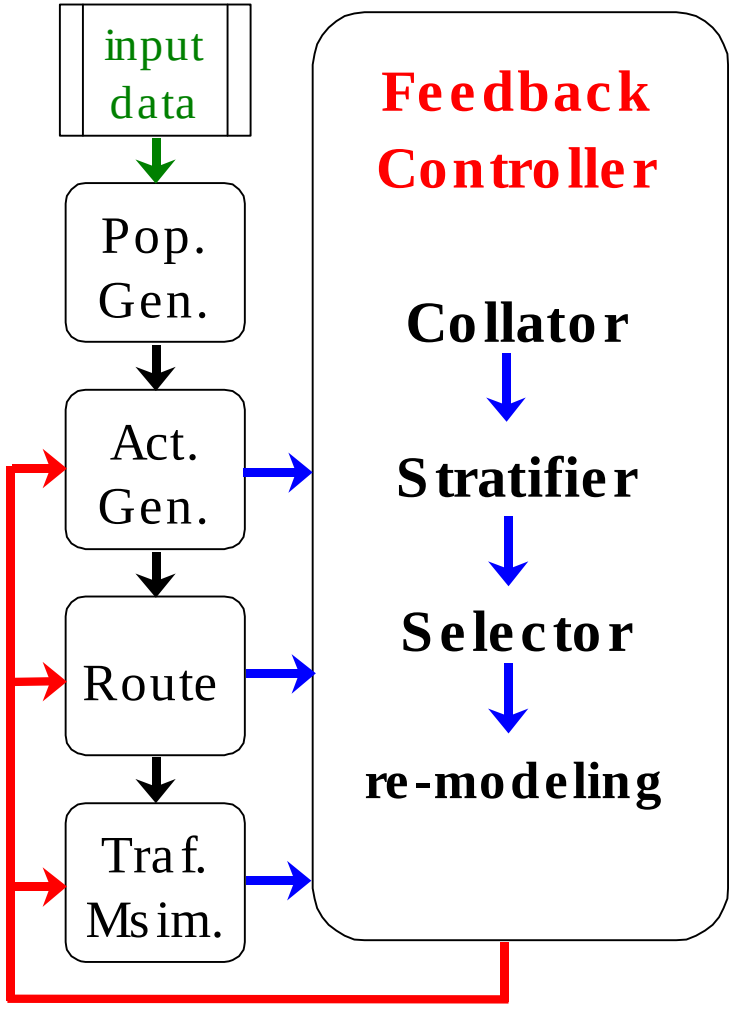
PRELIMINARIES: Stopping Criteria

- *Has target been reached within acceptable tolerance?*

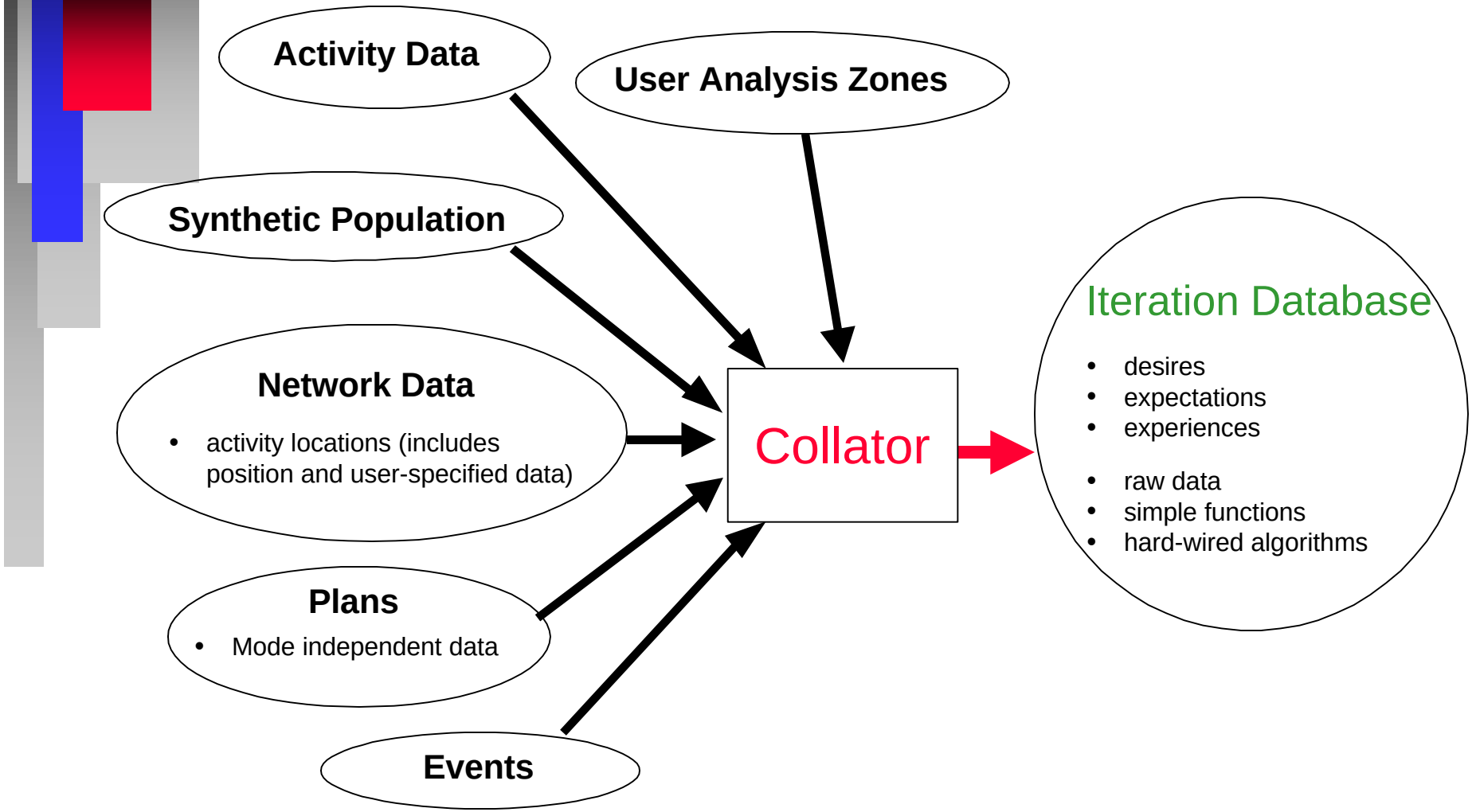


TOOLS

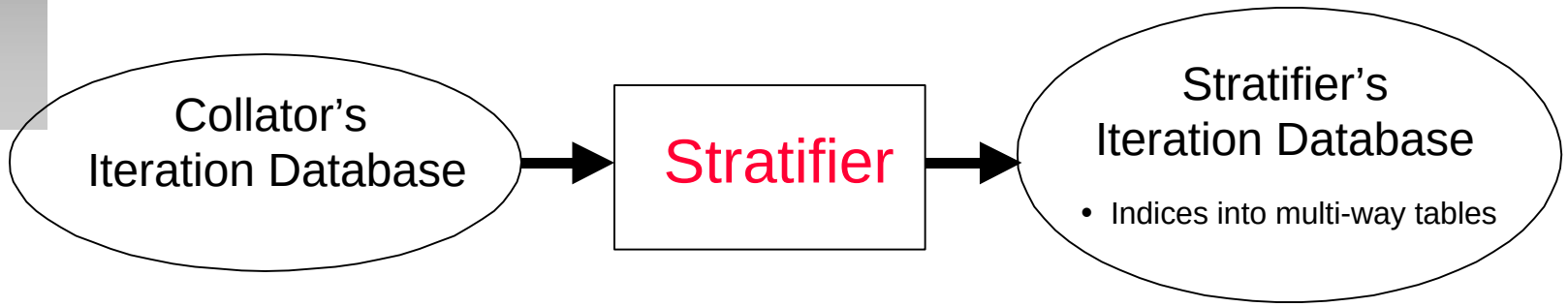
- *Collator*
- *Stratifier*
- *Selector*
- *Feedback controller*



TOOLS: Collator



TOOLS: Stratifier



	cross river	no river
poor	A,D,G	B
rich	E,F	C

TOOLS: Selector

- *Select a bin of traveler-trips*
  - *highest variance about bin-target*
  - *worst deviance from bin-target*

- *Select traveler-trips within that bin*
  - *maximum cost traveler-trips*
  - *uniformly randomly*
  - *other statistical sampling*

TOOLS: Feedback Controller

Make use of TOOLS to reach target:

```
Do {
    activity feedback
    Do {
        route feedback
    } until routes equilibrated
} until activities equilibrated
```

EXAMPLES

- *Self-consistent modeling*
- *Correcting for poor input data*
- *Reaching a “target”*
- *Forecasting traffic for a given scenario & set of assumptions*

EXAMPLES: Self-consistent Modeling

- *Feedback Controller:*

do {

(Collator, Stratifier - not used)

Select uniformly randomly

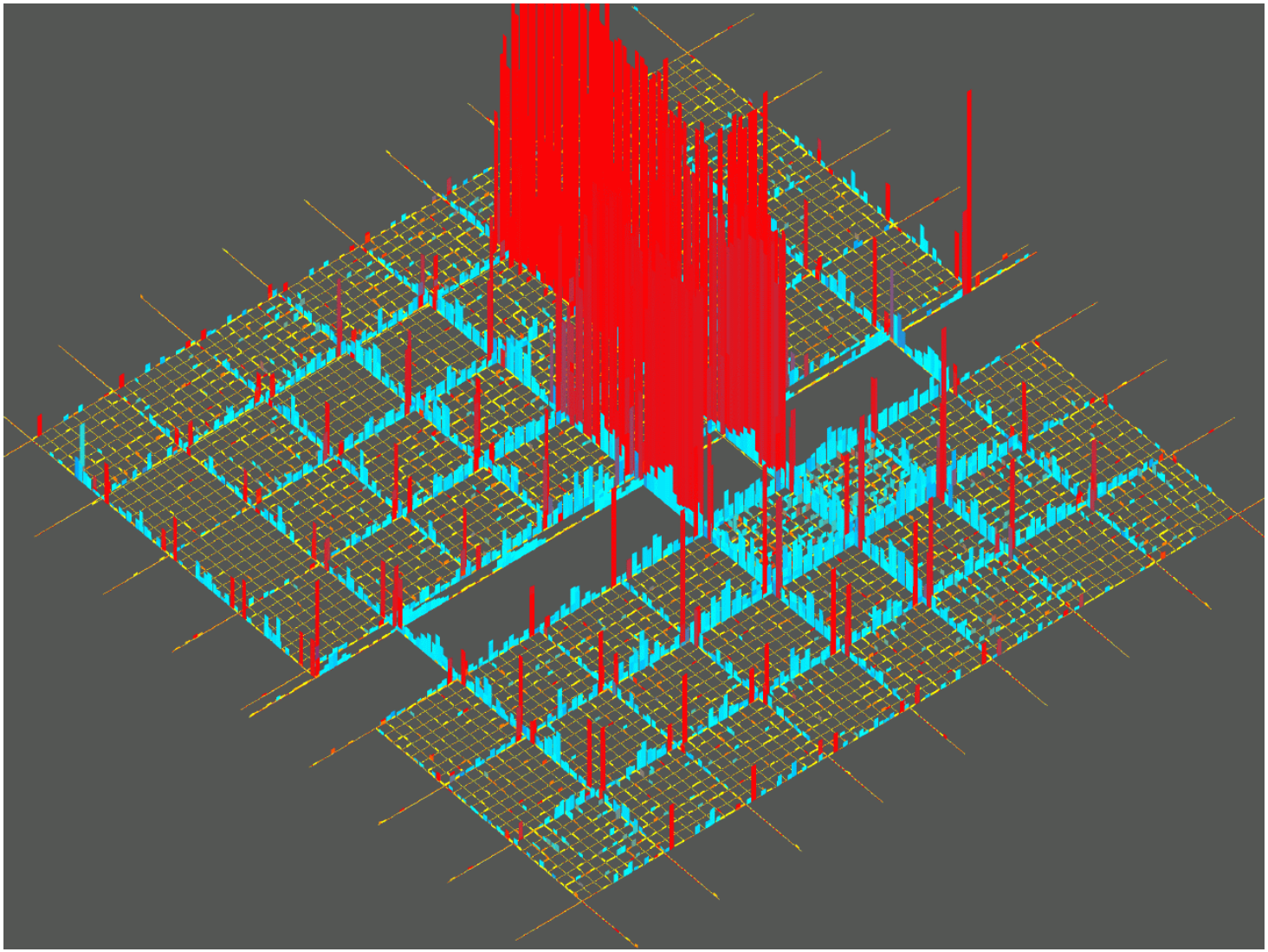
reRoute selected travelers

Microsimulate all travelers

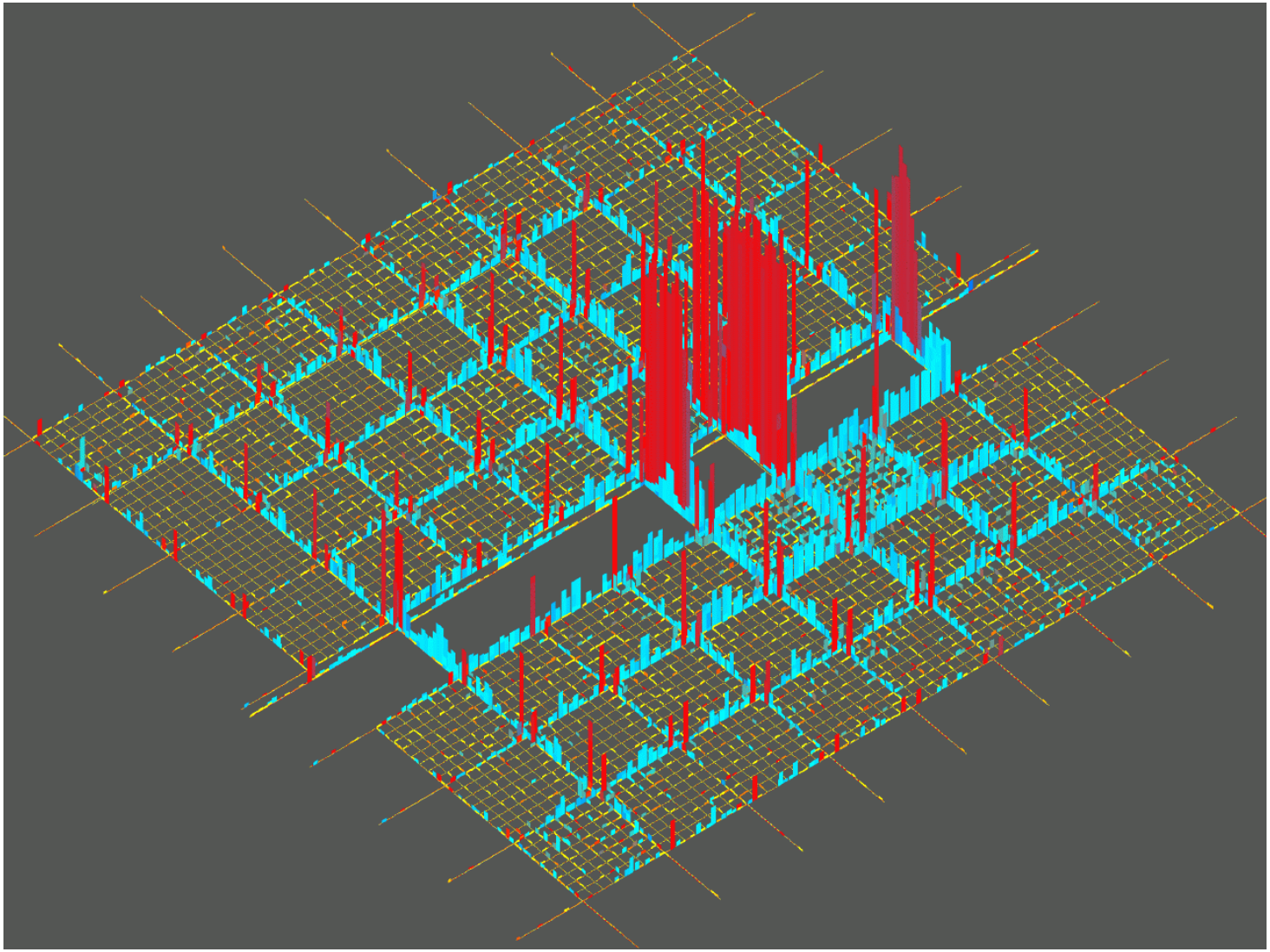
update travel times

} until routes/times stop changing

EXAMPLES: Self-consistent Modeling



EXAMPLES: Self-consistent Modeling



EXAMPLES: Poor Input Data

Correct locations, modes, and activity times based on obvious problems:

- *excessive walk times (esp. school trips)*
- *identify candidates for park & ride*
- *ridiculous auto/transit trips*
- *un-routable trips*

EXAMPLES: Poor Input Data

- *Feedback Controller:*

  Collate, Stratify by problem type

  for each problem type {

  Select problem travelers

  fix problem

  }

  regenerate Activities if necessary

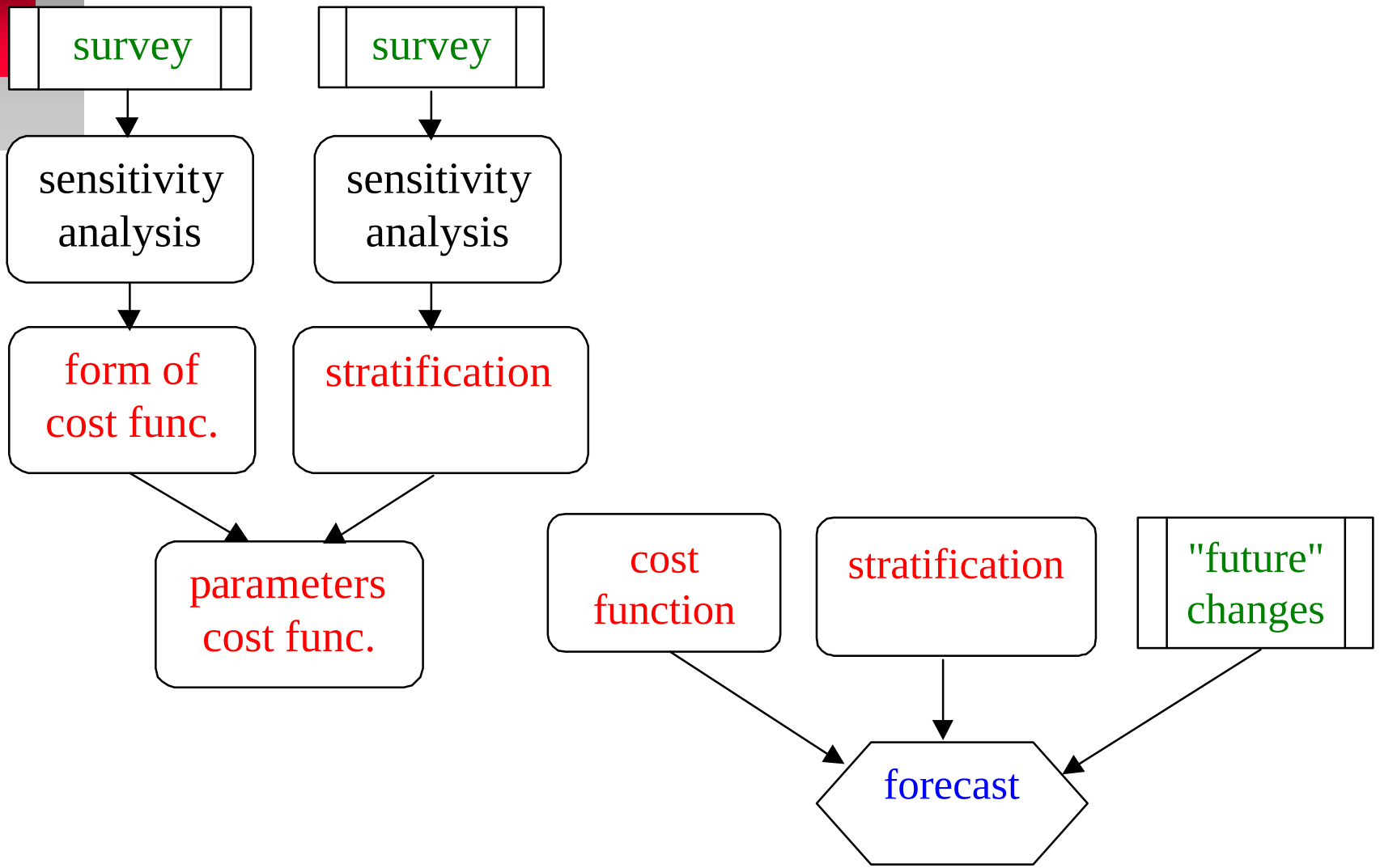
  reRoute selected travelers

  Microsimulate all travelers

EXAMPLES: Forecasting Mode Split

- *Must first calibrate a method which produces the known mode-split for the original data*
- *Make a change to the network or population*
- *Use calibrated method to determine a likely mode split given that change*

EXAMPLES: Forecasting Mode Split



EXAMPLES: Forecasting Mode Split

- *Stratification:*
  - *choose desired groupings*
  - *determine what variables allow the different groups to be differentiated*

EXAMPLES: Mode Split: Stratification

Feedback Controller to determine stratification for mode choice:

do {

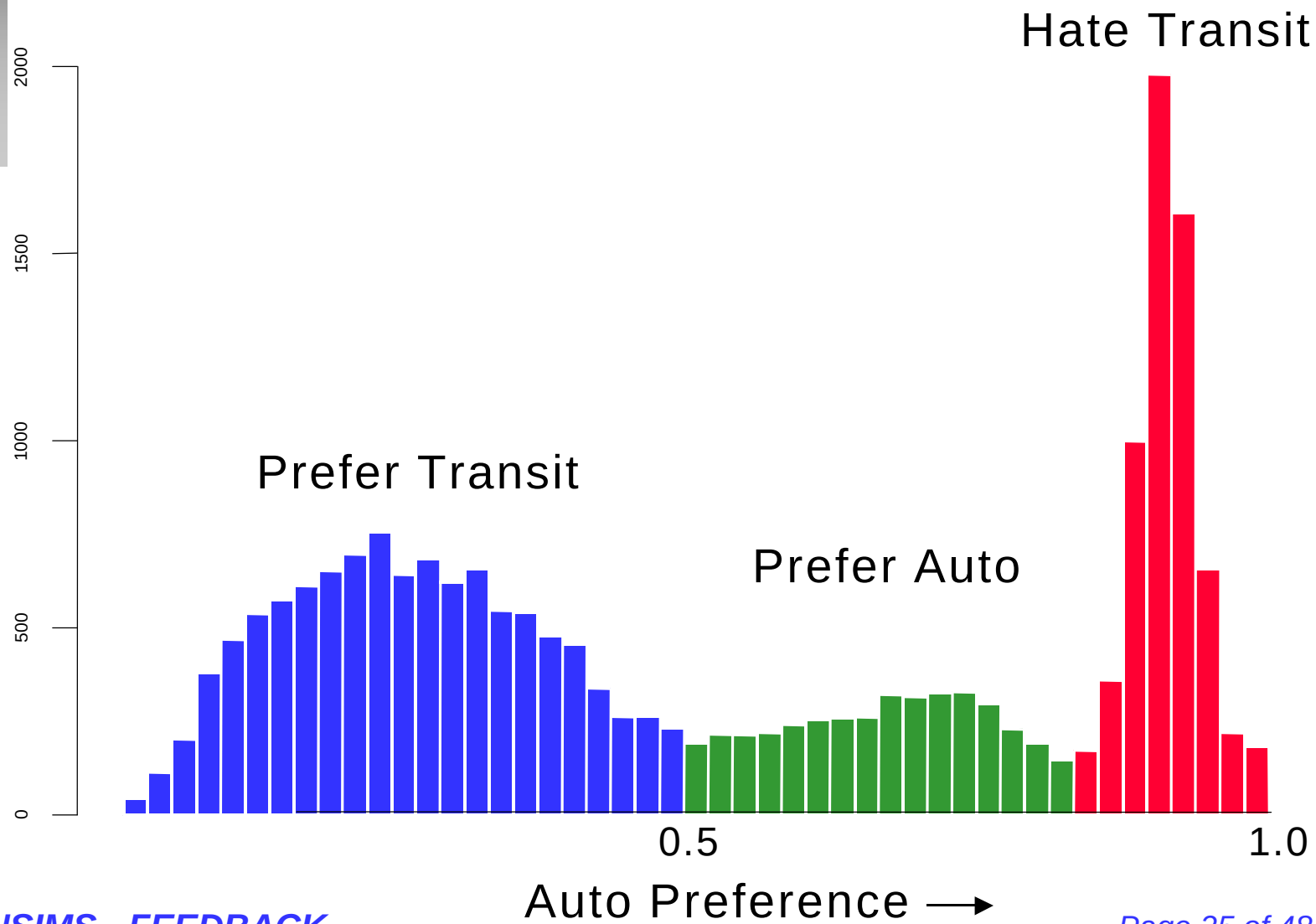
Select travelers uniformly randomly

re-mode & reRoute selected travelers

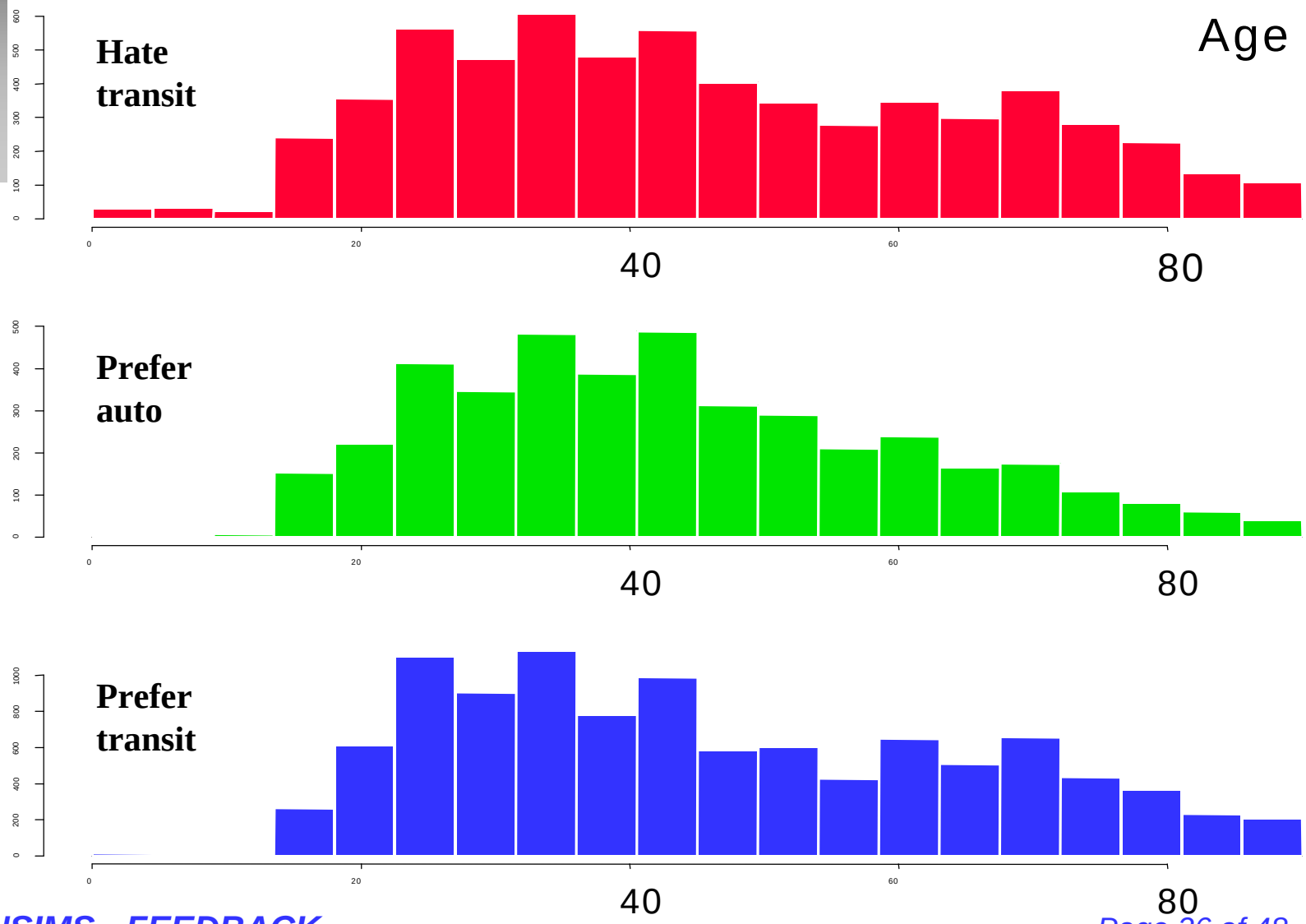
update preference distribution

} until preference distribution equilibrates

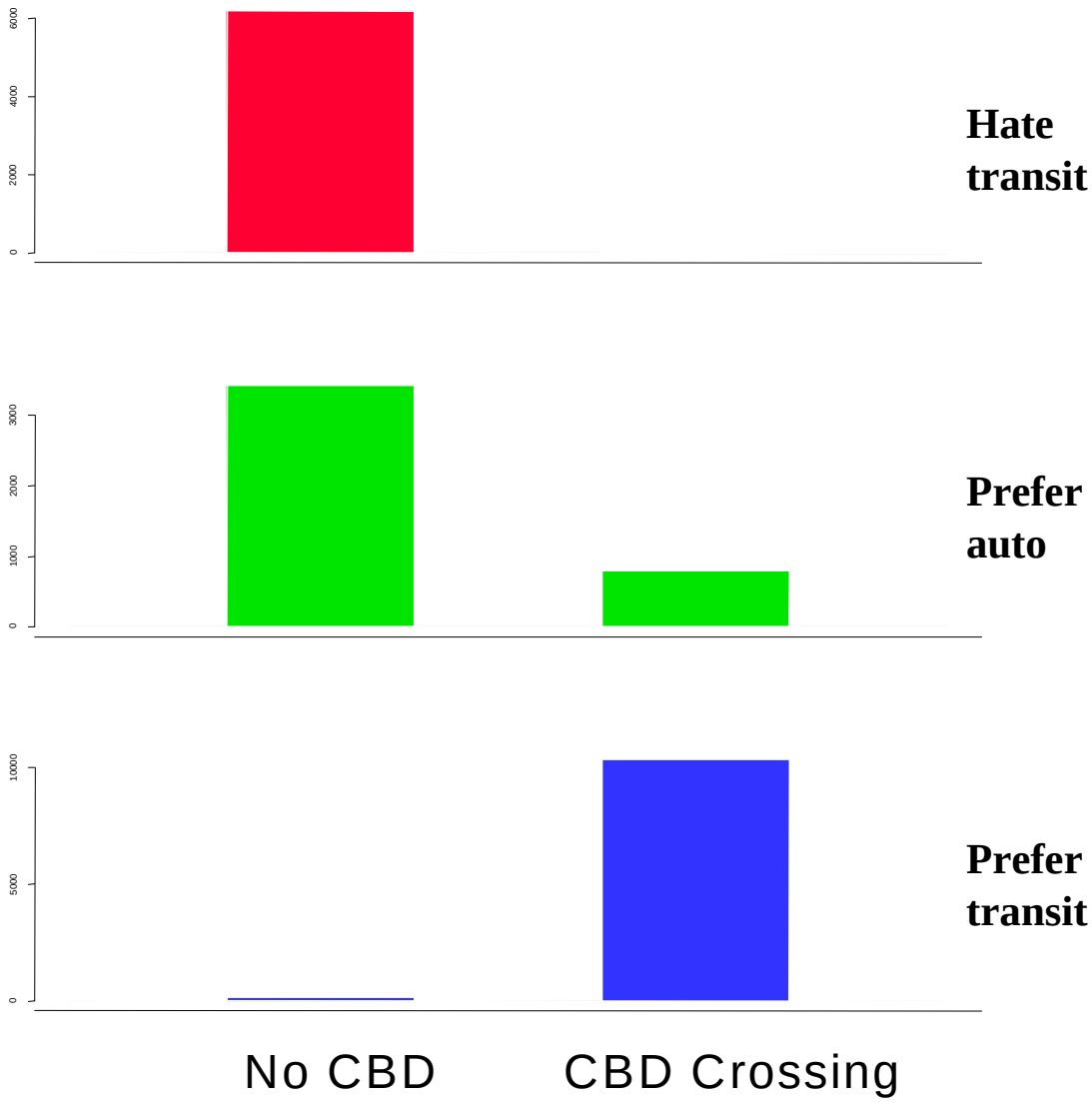
EXAMPLES: Mode Split: Stratification



EXAMPLES: Mode Split: Stratification



EXAMPLES: Mode Split: Stratification



EXAMPLES: Mode Split: Stratification

- *Correlation of distributions between groups suggests which variables to use:*

	1 and 2	1 and 3	2 and 3
Cross CBD	0.97	-0.48	-0.28
Cross River	-0.07	0.43	0.87
Age	0.96	0.99	0.95
Income	0.93	1.00	0.95

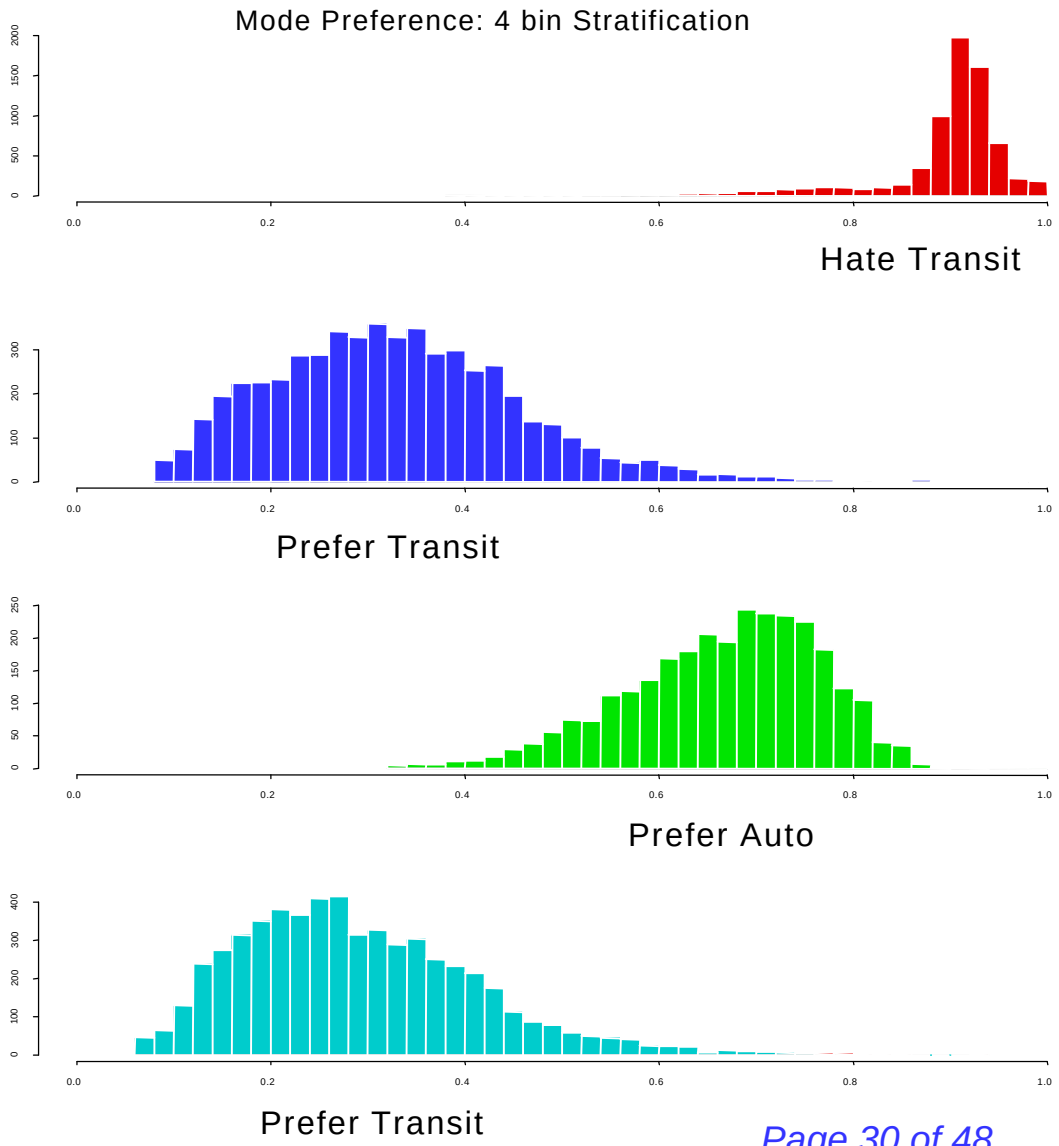
EXAMPLES: Mode Split: Stratification

- *Resulting Stratification:*

	Cross CBD	Don't cross CBD
Cross river	40%	24%
Don't cross river	12%	24%

EXAMPLES: Mode Split: Stratification

- *Resulting stratification does distinguish groups*



EXAMPLES: Mode Split: Cost function

- *Mode choice dependencies:*

  travel time, monetary cost,

  travel distance, income

- *A form for the (mode choice) cost function:*

$$\text{Cost} = \frac{a \cdot \text{TravelTime} \cdot \text{Salary} + \text{DollarCost}}{\text{Distance}}$$

EXAMPLES: Mode Split: Cost function

Feedback Controller to determine parameters:

```
do {
    change parameters
    do {
        activity feedback for modes
        do {
            route feedback
        } until routes are equilibrated
    } until activities are equilibrated
} until mode split matches target
```

EXAMPLES: Mode Split: Cost function

- *Given an auto/transit mode split of 9/1, the parameterized cost function becomes:*

$$\text{Cost} = \frac{7.7 \cdot \text{TravelTime} \cdot \text{Salary} + \text{DollarCost}}{\text{Distance}}$$

EXAMPLES: Forecasting Mode Split

- *Must first calibrate a method which produces the known mode-split for the original data*
- *Make a change to the network or population*
- *Use calibrated method to determine a likely mode split given that change*

EXAMPLES: Forecasting Mode Split

Feedback Controller:

```
do {
    activity feedback for mode choice
    do {
        route feedback
    } until routes are equilibrated
} until activities are equilibrated
```

EXAMPLES: Forecasting Mode Split

- *Activity Feedback sub-Controller:*

do {

Collate, Stratify

Select un-equilibrated bins

Select travelers uniformly randomly

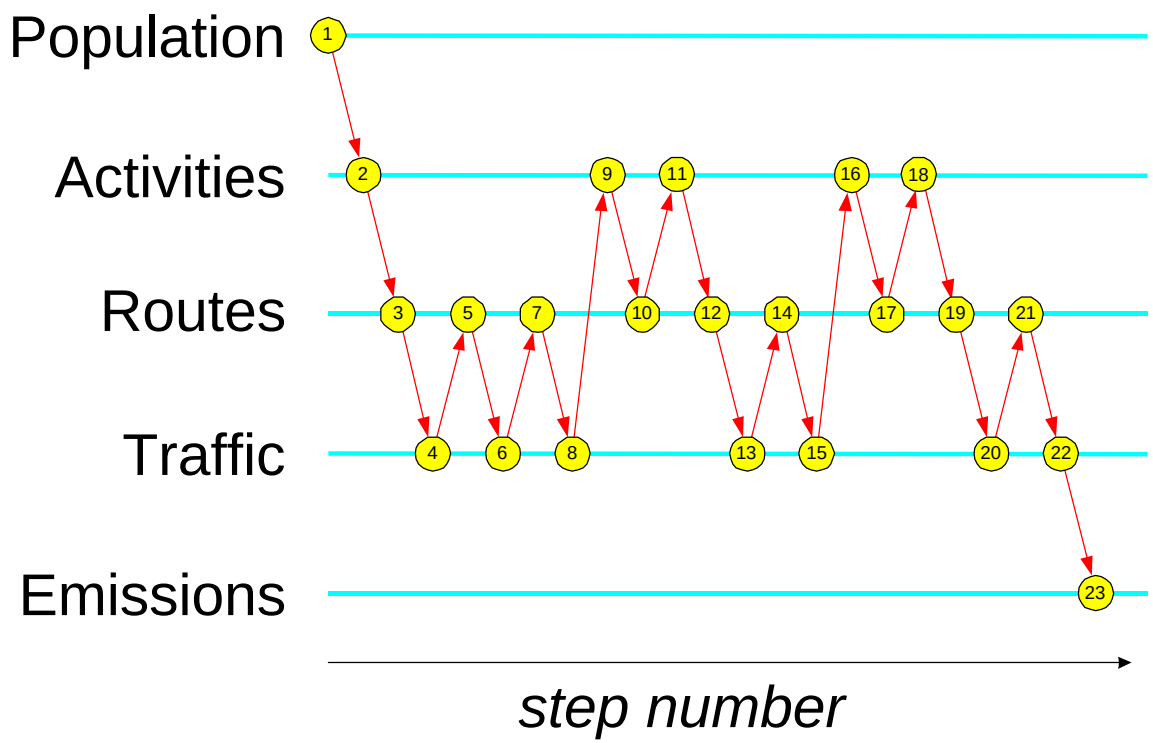
re-mode & reRoute selected travelers

update bin's preference distribution

} until mode split in each bin equilibrates

EXAMPLES: Forecasting Mode Split

Likely instance (whole thing):



EXAMPLES: Forecasting Mode Split

- *In the original run, the auto/transit mode split was 9/1*

- *Do 3 forecast studies:*

  1. *same population, reduced transit*
  2. *doubled population, same transit*
  3. *doubled population and reduced transit*

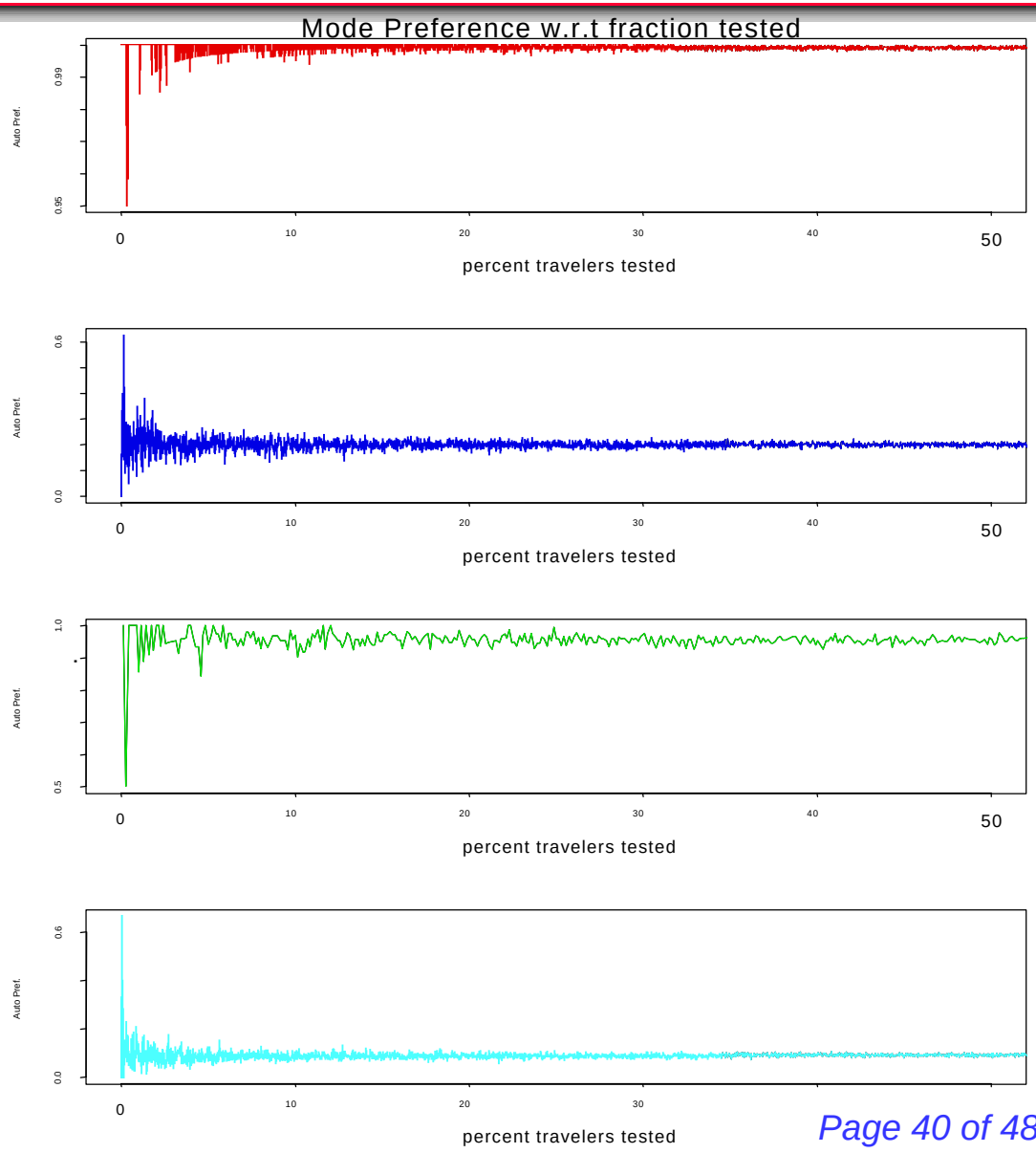
EXAMPLES: Forecast 1

- *Same population*
  - *37789 households*
  - *70355 people*
- *Reduced transit schedule from*
  - *one route every 10 minutes*
  - *24 hrs a day*

  to
  - *one every 20 minutes*
  - *between 6 AM and 8 PM only*

EXAMPLES: Forecast 1 : Same population, reduced transit

Cross River?	End in CBD?
No	No
No	Yes
Yes	No
Yes	Yes



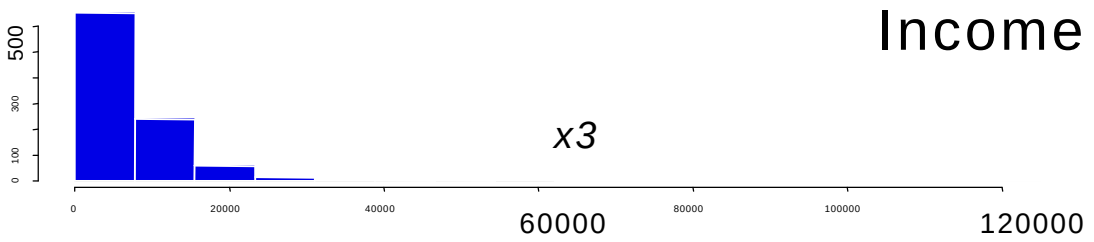
EXAMPLES: Forecast 1 : Same population, reduced transit

- *What is the resulting mode split?*
  - *93% on auto*
  - *7% on transit*

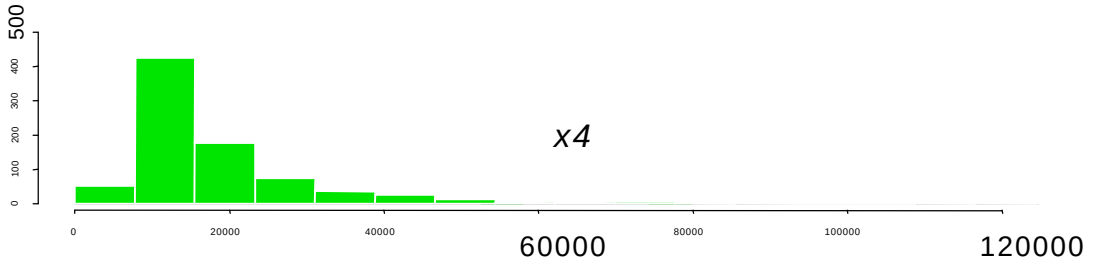
- *What are the changes?*
  - *6% stay on transit*
  - *5% switch from transit to auto*
  - *1% switch from auto to transit*
  - *88% stay on auto*

EXAMPLES: Forecast 1: Who switches from transit? (by income)

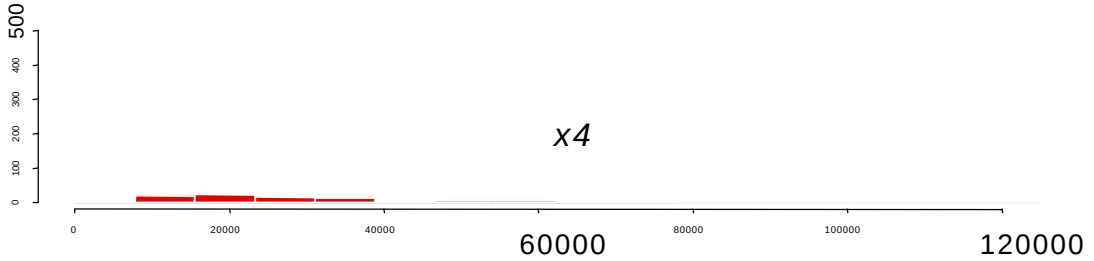
Stay on transit



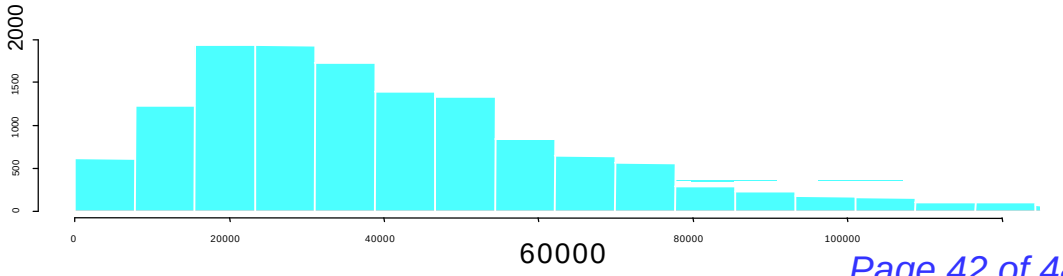
Switch to auto



Switch to transit

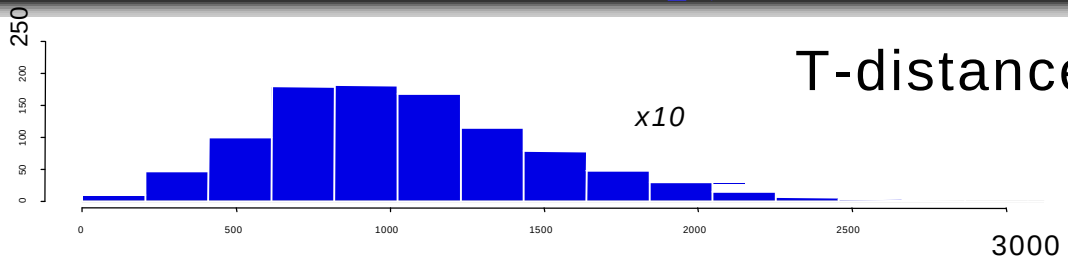


Stay in auto

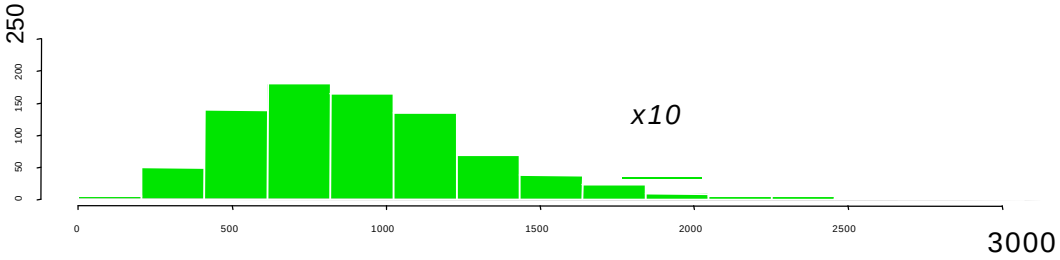


EXAMPLES: Forecast 1: Who switches from transit? (by distance to transit stop)

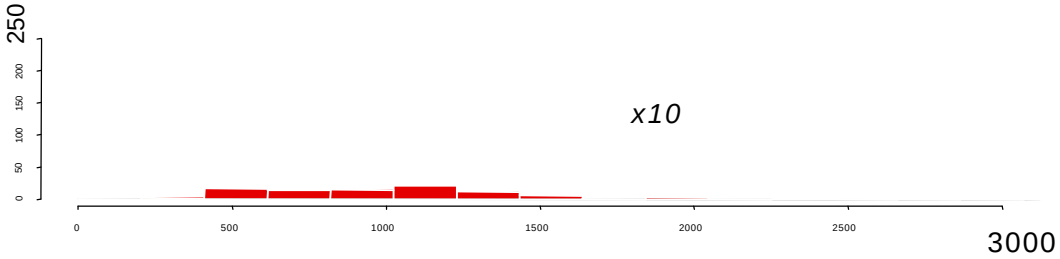
Stay on transit



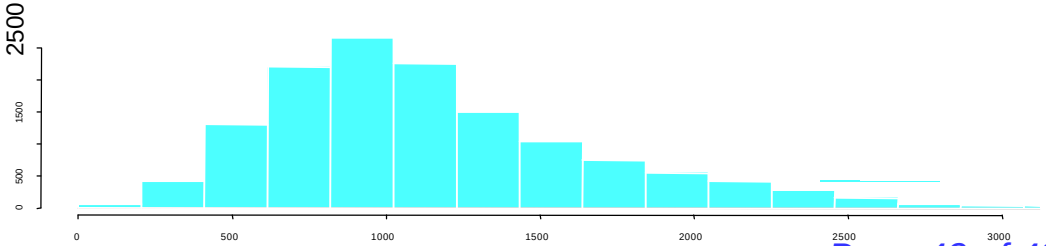
Switch to auto



Switch to transit



Stay in auto



EXAMPLES: Forecast 2

- *Same transit schedules*
  - *every 10 minutes*
  - *24 hours a day*
- *Increase the population from*
  - *37789 households*
  - *70355 people*

  to
  - *60452 households*
  - *119998 people*

EXAMPLES: Forecast 2: Double population, same transit

- *What is the resulting overall mode split?*
  - *88% on auto*
  - *12% on transit*

EXAMPLES: Forecast 3

- *Change both population and transit schedules to*
  - *60452 households*
  - *119998 people*

  and
  - *one transit route every 20 minutes*
  - *between 6 AM and 8 PM only*

EXAMPLES: Forecast 3: Double population and reduced transit

- *What is the resulting overall mode split?*
  - *92% on auto*
  - *8% on transit*

SUMMARY

- *The TRANSIMS framework provides*
  - *feedback information pathways*
  - *tools for manipulating the information*
- *Feedback can be used to*
  - *calibrate component models*
  - *nudge the system into Nash equilibrium*
  - *forecast the response to changes subject to constraints*
  - *examine the demographics of affected travelers*
- *TRANSIMS does not provide cookbook recipes*
  - *each city has unique aspects*
  - *there are many approaches to doing each forecast*
  - *simulation is not a substitute for thought*